

Appl. No. 09/844,533  
Response to Office Action mailed October 10, 2003

REMARKS

The feature of basicity (ratio of CaO/SiO<sub>2</sub> of 1.5 or higher) that was introduced into claims 18 and 19 is supported in the specification on page 23, lines 6 to 9.

The feature of "rearing algae and water living creatures" introduced into claims 18 and 19 is supported in the specification on page 5, lines 6 to 20; page 13, lines 5 to 11; and page 52, lines 2 to 3.

With respect of 37 CFR 1.116, entry of the above amendments is respectfully requested, since other than the features discussed above, the amendments do not involve any features that were not previously presented. Moreover, it is respectfully submitted that the above amendments place the application in a better position for allowance.

Prior to addressing the prior art rejection, the presently claimed invention is discussed as follows in the context of the art.

The underwater immersion block, according to applicants' claim 18, employs steel making slag mixture having a basicity in terms of a weight ratio of CaO to SiO<sub>2</sub> of 1.5 or higher as a planting place for algae growth and for rearing water living creatures. The underwater immersion block has a porous structure

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on the surface and inside of the block. The porosity is defined in claim 18 as being from 10 to 70%. The porous structure of the surface results in easy adhesion of marine algae to the surface of the block, which is effective for accelerating the growth of marine algae and for their ready elution to seawater. It is an important feature of the presently claimed invention to effectively and rapidly accelerate the growth of marine algae, as compared with the use of concrete fishing banks comprising an aggregate made of iron slag.

The cited art does not disclose or suggest a block prepared from a granular steel making slag mixture having a porosity that is fully within the range of 10 to 70% and concomitantly results in the growth of algae. Therefore, it is respectfully submitted that the present claim 18 is clearly patentable over the cited references.

As recited in applicants' present claim 19, the packed bed comprising a granular steel making slag mixture (having a basicity in terms of a weight ratio of CaO to SiO<sub>2</sub> of 1.5 or higher) has a bulk specific gravity/true specific gravity ratio of 0.3 to 0.9. If the bulk specific gravity/true specific

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gravity ratio exceeds 0.9, the permeability of the packed bed is deteriorated and the carbonation treatment cannot be sufficiently carried out. If the bulk specific gravity/true specific gravity ratio is under 0.3, the contact among the slag granules decreases and the strength of the produced block decreases.

The cited art references do not teach or suggest a method of producing a block wherein the packed bed has a bulk specific gravity/true specific gravity ratio of 0.3 to 0.9. Therefore, it is respectfully submitted that the present claim 19 is patentable over the cited prior art.

The presently claimed invention serves as a countermeasure against some of the existing worldwide environmental problems, such as providing fresh air and reducing water contamination.

The present invention serves to clean the sea by promoting photosynthesis (i.e., the production by green plants of special substances, caused by the action of sunlight on chlorophyll).

Heretofore, various methods have been tried for making use of slag produced in the steel-making process as a seawater immersion block or a river-water immersion block for planting algae and/or gathering fish on the rocky places. However,

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unfortunately, such a massive slag has a disadvantage, which means, it has almost the same effect as a natural block, and thus it is not effective to accelerate the growth of sea algae.

Applicants discovered that to make effective use of slag from the steel-making process for planting algae, it was important that a certain size to some degree was needed. That is why broken slag cannot be used. In contrast thereto, to recover the metal from the slag, it is important that the slag should be pulverized into a small size to some degree.

Concerning another problem regarding making use of an immersion block, the calcium content in the slag is dissolved into the water and, then, there arises the possibility of raising the pH value in the seawater or in the river-water into which the immersion block is placed. Furthermore, slag from the steel-making process contains a substantial amount of metal. So, if massive slag is immersed into the water directly, the grain iron is oxidized and there is a possibility to invite a shortage of oxygen. Not only by the reason of the immersion block-size, but also by the reason of the shortage of oxygen, the metal content should be sufficiently removed.

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Concerning the concrete block used in the Knopf et al. patents as discussed hereinbelow, by the reason of a high pH value (normally from 12 to 12.5), the pH in the water, such as in a river, may increase and may result in decreased algae growth.

A fishway made with concrete has a smooth surface at the bottom, which is not preferable for water creatures in water, such as in a river, especially for their movement on the riverbed. From this point of view, the present invention provides an advantageous result.

Claims 18, 19, 21 to 34, 36 to 53 and 55 to 58 were rejected under 35 USC 103 as being unpatentable over Knopf et al. USP 6,387,174 or USP 6,264,736.

It was admitted in the October 10, 2003 Office Action that Knopf et al. do not explicitly teach a specific porosity range ("it is not stated in either patent").

Knopf et al. (USP 6,387,174 and USP 6,264,736) do not teach or suggest the aforementioned advantageous features of the present invention which relate to the improvement of worldwide environmental problems. Knopf et al. merely disclose carbonating large cement structures, by forming and hardening cement in a

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mold under high carbon dioxide density, such as supercritical or near-supercritical conditions.

The present invention provides several specific features that are not taught or suggested by Knopf et al., such as a sufficiently porous structure, a specific bulk specific gravity/true specific gravity and other technical specific features that provide desirable results, for example, breeding marine algae to solve the shortage of oxygen in sea water.

The following position was taken at the middle of page 2 of the October 10, 2003 Office Action:

"Applicants provide no experimental data clearly showing these patents teach porosity outside the range of their invention."

In reply to the above allegation set forth in the final rejection, submitted concomitantly herewith are two DECLARATIONS UNDER 37 CFR 1.132 of Tatsuhito TAKAHASHI dated February 4, 2004. With respect to 37 CFR 1.116, consideration of both of the enclosed TAKAHASHI DECLARATIONS is respectfully requested, since the two TAKAHASHI DECLARATIONS serve to reply to positions taken in the final rejection. One of the TAKAHASHI DECLARATIONS

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includes Tables A and B; the other TAKAHASHI DECLARATION includes color photos A to E (the photos A to E show the advantageous features of the present invention).

Attention is directed to Tables A and B in the enclosed TAKAHASHI DECLARATION, which provide the results of comparison testing between a marine block made from steel-making slag, such as in the presently claimed invention, and a cement concrete block, such as discussed by the Knopf et al. patents.

As seen from Tables A and B in the enclosed TAKAHASHI DECLARATION, the percentage of porosity for cement concrete falls within the limited range of 8% to 40%. In the case of such cement concrete, this range is the usual range to maintain the compressive strength. As can be clearly seen from Table A in the enclosed TAKAHASHI DECLARATION, the compressive strength of the cement concrete decreases proportionally with an increase in porosity.

In the higher percentage range of the porosity, the cement concrete does not possess a useful compressive strength. More importantly, only in the direction to make the porosity smaller

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can the compressive strength of the cement concrete be maintained.

Stated differently, with respect to concrete cement, it is quite natural that the smaller porosity becomes, the higher the compressive strength becomes. When gaseous material (e.g., air) is removed from the main material, the density consequently becomes higher. This is known to one of ordinary skill in the art.

In contrast to cement concrete as used in Knopf et al., in the presently claimed invention, a wide range of porosity of 10 to 70% for the marine block (underwater immersion block) is afforded. As seen from Table A in the enclosed TAKAHASHI DECLARATION, in the claimed porosity range of 10 to 70%, a usable compressive strength of 30 to 230 kg/cm<sup>2</sup> is provided.

Table A in the enclosed TAKAHASHI DECLARATION shows that conventional concrete cannot obtain the desirable result for growing algae within a sufficient range of the compressive strength. This is substantially different from the presently claimed invention.

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The results with respect of the growth of algae are shown in the column in said Table entitled "Growth of Algae" and said results are based on the condition immediately after immersion and after a half-year passes. Such results with respect of algae growth, coupled with the results shown for compressive strength, demonstrate a clear distinction between the Example (Marine Block) and the Comparative Example (Cement Concrete).

The amount of the algae growth is not correlated to a stronger compressive strength. Normally, compressive strength is enough to be equal to or over 30 kg/cm<sup>2</sup>, for using the block in seawater. In order for algae to grow, a stronger compressive strength is not indispensable. Rather than a stronger compressive strength, it is very important to have a wide range of usable and adequate porosity area.

There is also an essential difference between the Example (Marine Block) and the Comparative Example (Cement Concrete) in Table A in the TAKAHASHI DECLARATION with respect of material characteristics. In the case of the cement concrete, the evaluation factor is compressive strength. This refers merely to a hardening so that the cement will not be destroyed.

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Furthermore, in the case of the cement, permeability means the coefficient of water permeability. In contrast thereto, the present invention involves a solidification by carbonation. Moreover, the presently claimed invention involves a controlled range of the porosity for algae to grow to a great extent. Still further, the present invention employs a steel making slag for algae growth.

As seen from Table A in the TAKAHASHI DECLARATION, for the marine block, algae growth is "good" and the compressive strength is 230 to 100 kg/cm<sup>2</sup> in a porosity range of 20 to 40%. In contrast thereto, at a porosity of 10% of the cement concrete, although the compressive strength is 230 kg/cm<sup>2</sup>, the growth of algae is "not good."

"Compressive strength" can be defined in accordance with "bulk density" and "true specific gravity." The present application was published as 2001/0054253A1. In said published application, the terminology of "to maximize the compressive strength" is set forth in Paragraphs 274, 278, 370 and 374. Furthermore, in Paragraphs 215, 227, 228, 244, 333, 339, 383 and 429, the term "strength" is set forth, the actual meaning of

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which can easily be understood to be the same as "compressive strength" in concrete technology.

Another difference between the cement block of the Knopf et al. patents and the underwater immersion block of the present invention is that the present invention enables carbonation of the marine block, simultaneously with maintaining the higher porosity. In other words, the present invention makes it possible to carbonate the marine block simultaneously with providing a spacious area for supplying air.

As described in detail hereinbelow, the above-described advantageous properties of the present invention, compared to the cement structures of the Knopf et al. patents, result in the desirable substantial promotion of algae growth.

In order to breed plants, it is essential to supply gas. With respect to cement structures having a low porosity (very fine blocks), algae cannot be generated because gas cannot be sufficiently furnished therethrough.

In contrast to the cement structure of the Knopf et al. patents, the present invention results in a porous structure, rather than a structure that is too fine. Such porous structure

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of the presently claimed invention desirably promotes algae growth.

The following was stated at the bottom of page 2 of the October 10, 2003 Office Action:

"Nevertheless, even if the claimed porosity range is not explicitly stated in the Knopf patents, the porosity of the cement which contains iron and slag (see col. 8, line 28 of 73681) is within the control of one of ordinary skill in the art and the examiner fails to see how simply claiming a porosity value makes their invention unobvious over the prior art."

Applicants respectfully rebut the above position taken in the Office Action, based on the following reasons. From the viewpoint of the slag itself, Knopf et al. (USP 6,387,174) state that the cement slag is a "standard pig-iron blast furnace slag" (see column 8, line 28 of USP 6,264,736). In contrast thereto, the present claims explicitly recite that the slag is a steel making slag. Thus, the respective slags of the Knopf et al. patents and the presently claimed invention are substantially different.

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It is difficult for a steel making slag to become a gel.

Gelation is a function of the CaO/SiO<sub>2</sub> ratio (slag basicity).

The higher the SiO<sub>2</sub> content, the greater the possibility for gelation to occur. Steel making slag in the present claims is defined as having a CaO/SiO<sub>2</sub> ratio of 1.5 or higher.

In contrast to a steel making slag, as an extreme example, cement is a kind of a gel, which induces water.

It is an important advantage of the present invention that the steel making slag does not become a gel.

Furthermore, a steel making slag has a high content of ferrite and phosphorus, which are nutritious components and serve as nourishment for the growth of algae.

Concerning slag basicity, the following is stated on page 22, lines 6 to 9 of the present specification:

"The agglomerate of solid particles has a better reactivity with CO<sub>2</sub> if the weight ratio (basicity) of CaO to SiO<sub>2</sub> is 1.2 or higher and desirably, 1.5 or higher."

The following is stated on page 23, lines 15 to 25 of the present specification:

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"...in the agglomerate of solid particles to be the CO<sub>2</sub> absorbing material, it is preferable that the basicity be high, for example, an agglomerate of solid particles where the basicity is less than 1.5 as the water granulated slag has a poor solubility of Ca ion, and is low in the reactivity with CO<sub>2</sub>, and therefore it may not be said that the function as the CO<sub>2</sub> absorbing material is fully exhibited. This is the reason why solid particles having a low basicity have a small amount of calcium silicate to be carbonized (e.g., 2 CaO · SiO<sub>2</sub> or 3CaO · SiO<sub>2</sub>), or have much glass as the water granulated slag." (emphasis provided)

The agglomerate of solid particles in the presently claimed invention has a better reactivity with CO<sub>2</sub> if the weight ratio (basicity) of CaO to SiO<sub>2</sub> is high, and from this viewpoint, it is preferable that CaO/SiO<sub>2</sub> is 1.2 or higher and, more desirably, 1.5 or higher.

When a steel making slag is used for a material for carbonation to result in a marine block, the slag basicity is equivalent to higher than 1.2. However, a steel making slag, which possesses a slag basicity 1.5 or higher, is more advantageous for the carbonation reaction.

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It is respectfully submitted that the Knopf et al. patents do not teach the above-described advantageous feature of the present invention.

The following is stated in the paragraph bridging pages 2 and 3 of the October 10, 2003 Office Action:

"Knopf 73621, for example, teaches that carbonation reduces the permeability of cement (col. 1, line 43) which is the porosity of the cement and one of ordinary skill in the art would have understood that control of the amount of carbonation would affect overall porosity or permeability."

It is respectfully submitted that the results in Tables A and B in the enclosed TAKAHASHI DECLARATION rebut the above position taken in the Office Action for the following reasons.

Table A of the enclosed TAKAHASHI DECLARATION shows the following advantages:

(1) The example according to the present invention provides a wider range of porosity in comparison with the comparative example (cement concrete).

(2) The example according to the present invention serves to control the compact strength, which is influenced by the

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porosity, to a wider extent in comparison with the comparative example (cement concrete).

The following is stated near the top of page 3 of the October 3, 2003 Office Action:

"As for density or specific gravity, again, there is no explicit teaching of a value for specific gravity with the exception of density values of .46 g/cc and .74 g/cc (col. 10, lines 55-60). Yet, control of density is also within the skill of one of ordinary skill in the art because again, the amount of carbonation reduces permeability or porosity which thus increases overall density. In column 3, line 41, Knopf et al. 736B1 teach that 'cements molded in the presence of high pressure carbon dioxide are significantly denser than otherwise comparable cements having no carbon dioxide treatment, and are also significantly denser than otherwise comparable cements treated with carbon dioxide after hardening.'"

Applicants rebut the above position taken in the Office Action for the following reason. In the prior art, carbonating is conducted after hardening the cement. Such carbonating is carried out under the condition of supercritical or near-supercritical condition. So, such density is nothing but the

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density when CO<sub>2</sub> exists under the critical or the near-supercritical condition. From this point of view, the prior art has no disclosure concerning the density of the solid material and the bulk specific gravity corresponding to the present invention.

The marine block of the presently claimed invention is not produced under supercritical conditions or in the neighborhood of supercritical conditions. The steel making slag used in the presently claimed invention is treated in a metal removal process, simultaneously or not simultaneously in a metal recovery process, and is pulverized and piled in an adequate size. Afterwards, the pit it is in is closed and carbon oxide is blown onto the materials for a determined number of days, and then the steel making slag is solidified. In this process, the present invention does not employ critical or supercritical conditions. Merely blowing is carried out. The present invention is achieved without so-called pressurizing conditions. In the present invention, there is no need to employ a compressing process.

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The blowing process used in the present invention is essentially different from the compressing process. Stated differently, to create supercritical conditions such as in the prior art, a compressing process is necessary.

The prior art teaches "large cement structure, by forming and hardening cement structures..., such as supercritical or near-supercritical conditions." (see the Abstract of Knopf et al., USP 6,264,736.) Also see claim 2 of Knopf et al. which states: "1(b) ...at a pressure of at least about 400 psi, until...."

Regarding cement structures, such supercritical or near-supercritical conditions are normally required for carbonation. In contrast thereto, the steel making slag used in the present invention requires merely blowing for carbonation, without supercritical or near-supercritical conditions, by the reason of the property of the steel making slag. In other words, this is a different primitive property between cement structures and the steel making slag used in the presently claimed invention.

Regarding the position taken with respect to algae growth at the middle of page 4 of the October 10, 2003 Office Action, applicants submit that desirable algae growth of the presently claimed invention is demonstrated in both of the enclosed

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TAKAHASHI DECLARATIONS, and that such feature is not taught by the references.

The rate of the algae growth provided by the present invention is unexpectedly superior to the use of the materials heretofore used for the reasons discussed hereinabove.

The following is stated at the bottom of page 4 of the October 10, 2003 office Action:

"Knopf 736B1 even teaches that near neutral pH's are needed for growth of most marine organisms. Neutral pH's would allow for the growth of both animal and plant life in marine environments. (see col. 4, lines 25-30)."

The Knopf et al. patents do not describe the promotion of algae growth. Table A in the enclosed TAKAHASHI DECLARATION shows that the marine block according to the present invention resulted in substantial algae growth, compared with cement as used in the Knopf et al. patents.

The results shown in Table A of the enclosed TAKAHASHI DECLARATION also serve to rebut the following statement at the middle of page 4 of the October 10, 2003 Office Action:

"... applicants fail to provide any experimental evidence that algae growth would not or could not occur in the underwater block of Knopf."

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It is respectfully submitted that the results shown in Table A of the enclosed TAKAHASHI DECLARATION, in conjunction with the above amendments to the claims, rebut the position taken in the last sentence in the first paragraph of page 5 of the October 10, 2003 Office Action.

The following concerns the advantageous carbonation of the present invention. The present specification discloses a method for preparing agglomerates of solid particles containing at least one compound selected from the group consisting of CaO and Ca(OH)<sub>2</sub>, contacting an exhaust gas containing CO<sub>2</sub> with the agglomerates of the solid particle in a reaction chamber, the solid particles having a film of adhesive water on a surface of the solid particles, fixing CO<sub>2</sub> in the exhaust gas as CaCO<sub>3</sub> to reduce CO<sub>2</sub> in the exhaust gas (page 10, line 6 from the bottom, to page 11, line 5 from the top of the specification). This film of adhesive water on a surface of the solid particles makes it easy to accelerate carbonation rapidly. This is a further important advantage of the present invention, focusing on the carbonation itself. As a result, the rapid growth of algae can

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be obtained in the present invention, compared with the cited prior art.

Paragraphs 82 and 90 of 2001/0054253A1 discuss the effectiveness of the surface adhesive water provided by the present invention. In paragraph 274, it is disclosed that water content is necessary for solidifying by carbonation. An optimum water content is described therein (see Photo A in the TAKAHASHI DECLARATION). The most suitable water content value exists in a state that the adhesive water exists on the surface of the particle.

In contrast to the present invention, the following is discussed in column 1, lines 25 to 37 of USP 6,264,736:

"Hardened or cured cements have sometimes been reacted with higher pressure or supercritical CO<sub>2</sub> to improve their properties. Supercritical and near-supercritical CO<sub>2</sub> increase the mobility of water that is already present in the cement matrix, water bound as hydrates and adsorbed on pore walls. A pore in the cement may initially contain supercritical or near-supercritical CO<sub>2</sub> at the pore entrance, a disperse water phase associated with the pore walls, and possibly free water at the CO<sub>2</sub>/water interface. The high CO<sub>2</sub> pressure increases the solubility of CO<sub>2</sub> in the dispersed aqueous phase. A concentration gradient of CO<sub>2</sub> is thus produced in the concrete pores. Carbon dioxide may then react with various cement components, particularly hydroxides of calcium."

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The above disclosure in USP 6,264,736 means that merely the adhesive water on the inside wall of the porous structure contributes to the carbonation reaction, where the CO<sub>2</sub> is in a condition of high-pressure.

There is no disclosure in the cited art for a carbonation reaction which contributes to the solidification (solidified combination) of the mutual particles to each as in the present invention.

In USP 6,264,736, at first hardening is done. Then curing is followed with hardening. The combination of the mutual particles results merely from hydration hardening, which is the same as concrete, as would be known by a person having ordinary skill in the art.

The features of the carbonation method of the present invention are described on page 10, lines 13 to 19 of the specification.

It is therefore respectfully submitted that applicants' claimed invention patentably distinguishes over the references. Reconsideration is requested. Allowance is solicited.

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If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned at the telephone number given below for prompt action.

Respectfully submitted,



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Encs.: (1) PETITION FOR EXTENSION OF TIME  
(2) DECLARATION UNDER 37 CFR 1.132 of  
Tatsuhito TAKAHASHI dated February 4, 2004,  
including Tables A and B  
(3) DECLARATION UNDER 37 CFR 1.132 of  
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